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The importance of maintaining accurate information on water depths and sediment distributions in coastal regions is becoming increasingly important as large groups of the global population concentration in these areas. Both commercial and defense segments of society require accurate and timely bathymetry in this dynamic environment. The traditional measurement techniques that have been used to monitor the evolution of these rapidly changing coastal zones are slow and expensive. As a result, charts of many parts of the world are grossly outdated. To lessen this problem, airborne lidar mapping systems have been developed and are currently being used. However, the performance of these systems is degraded by the numerous existent environmental conditions such as water clarity, water surface roughness, and bottom vegetation. To circumvent these problems, airborne electromagnetic (AEM) methods have been developed for measuring water depths and sediment conductivity from helicopter platforms. The first generation of digitally controlled AEM systems have been evaluated and found to provide accurate water depths and water conductivities from the shore to depths in excess of 20 m.

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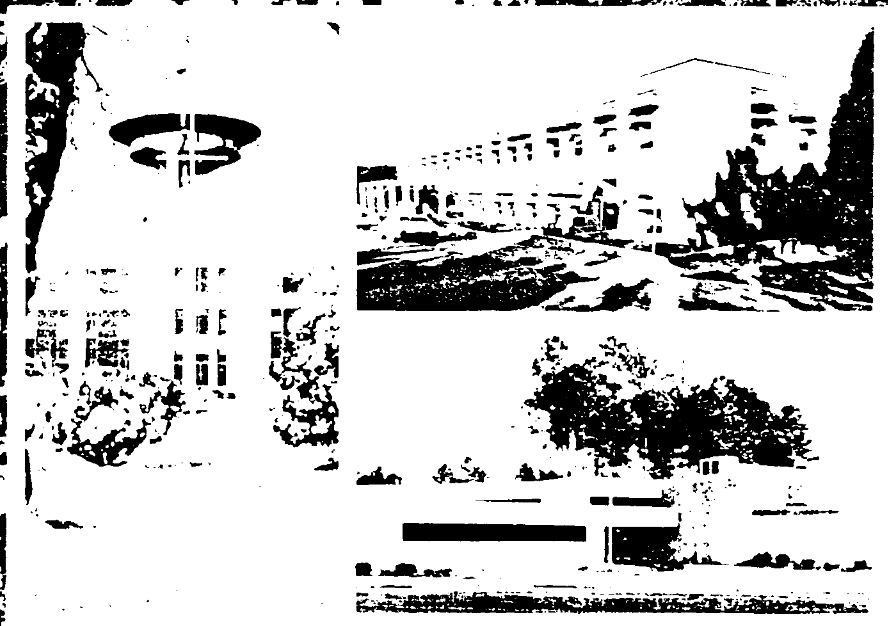

1993 NRL Review

Airborne Electromagnetic Hydrographic Techniques

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The importance of maintaining accurate information on water depths and sediment distributions in coastal regions is becoming increasingly important as large groups of the global population concentrate in these areas. Both commercial and defense segments of society require accurate and timely bathymetry in this dynamic environment. The traditional measurement techniques that have been used to monitor the evolution of these rapidly changing coastal zones are slow and expensive. As a result, charts of many parts of the world are grossly outdated. To lessen this problem, airborne lidar mapping systems have been developed and are currently being used. However, the performance of these systems is degraded by the numerous existent environmental conditions such as water clarity, water surface roughness, and bottom vegetation. To circumvent these problems, airborne electromagnetic (AEM) methods have been developed for measuring water depths and sediment conductivity from helicopter platforms. The first generation of digitally controlled AEM systems have been evaluated and found to provide accurate water depths and water conductivities from the shore to depths in excess of 20 m.

Measurement Fundamentals: The AEM bathymetry technique is based on the use of the physical phenomenon of electromagnetic induction in the seawater and seafloor sediments. When an electromagnetic transmitter is used above water overlying a saturated sedimentary sequence, the time varying primary fields will induce eddy currents within the water column that will in turn diffuse through water into the sediments at a rate defined by electrical conductivity of the media. The secondary fields, which are generated by the diffusive eddy currents that first move through the highly conductive water and then through the more resistive sediments, provide a frequency response that reflects both the depth and conductivity of the water as well as the conductivity of the sediments. The water conductivity is a function of water temperature and salinity, and the conductivity of the saturated sediments is related to both water conductivity and sediment porosity and permeability.

The AEM technique was developed in Canada during the 1950s as a mineral prospecting tool. Over the years, the technology evolved into sophisticated multifrequency systems capable of mapping sedimentary cover. These mapping systems required a large number of analog circuit elements that resulted in complex and poorly calibrated systems with very high drift rates. These system traits caused a high degree of uncertainty in the interpretation of the data. As a solution, the Navy developed a program to design and fabricate an advanced, digitally controlled, wide band AEM system. The system's characteristics are summarized in Ref. 1.

Field Results: The AEM hydrographic system was used over the St. Mary's river in the vicinity of Kings Bay, Georgia, entrance channel as shown in Fig. 7 to chart water depths and map variations in seafloor sediments. The survey provided a set of high quality data that overlapped a region covered by two high density acoustic surveys. In addition, in situ water temperature and conductivity measurements were obtained over the tidal cycle and along the surveyed channel.

The interpretation of the AEM data indicated that the inferred water conductivities agreed with in situ measurements to an accuracy of 0.1 Siemens/meter (S/m). The root mean square difference between the water depths that were provided by the AEM measurements and a suite of acoustic fathometer data was less than 0.6 m over an 11 km^2 subregion. A summary of the survey data and processing procedures are provided in Ref. 2. Figure 8 shows a map of the AEM water depths over the entire surveyed region. The seafloor conductivities were spatially coherent and provided a realistic range in values as Fig. 9 shows. These values correspond to a variation of bottom material ranging from a clean, well consolidated sand to a poorly consolidated clay or silt. Thus, the technique

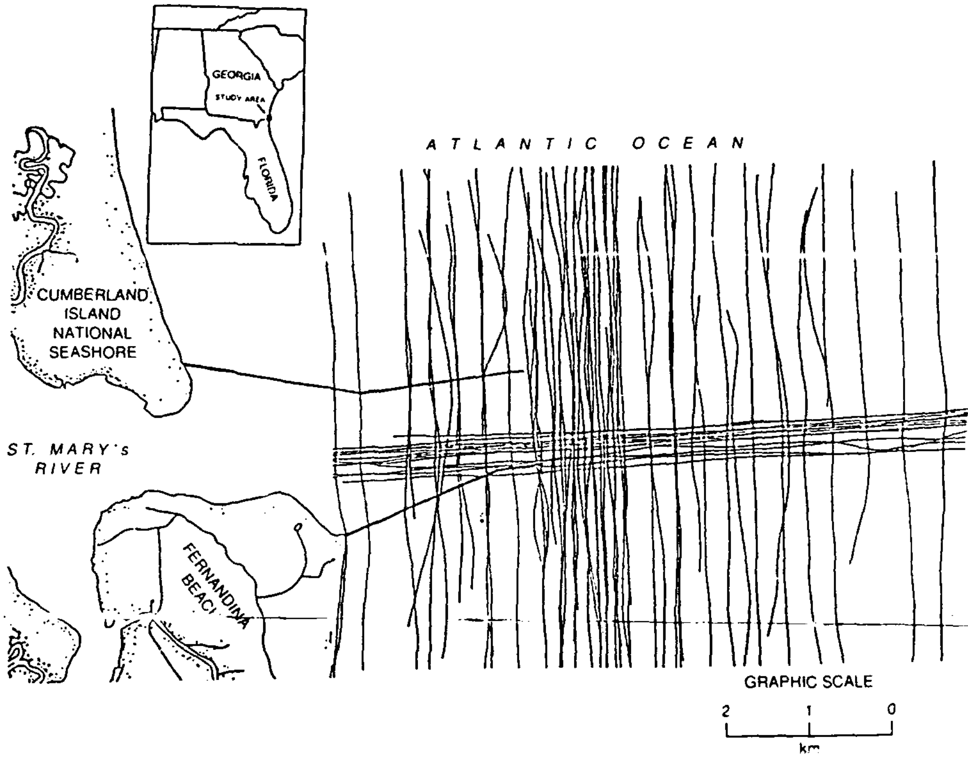

Fig. 7 — Map of the location where AEM flight lines were distributed and data were collected at a rate of 30 samples per second

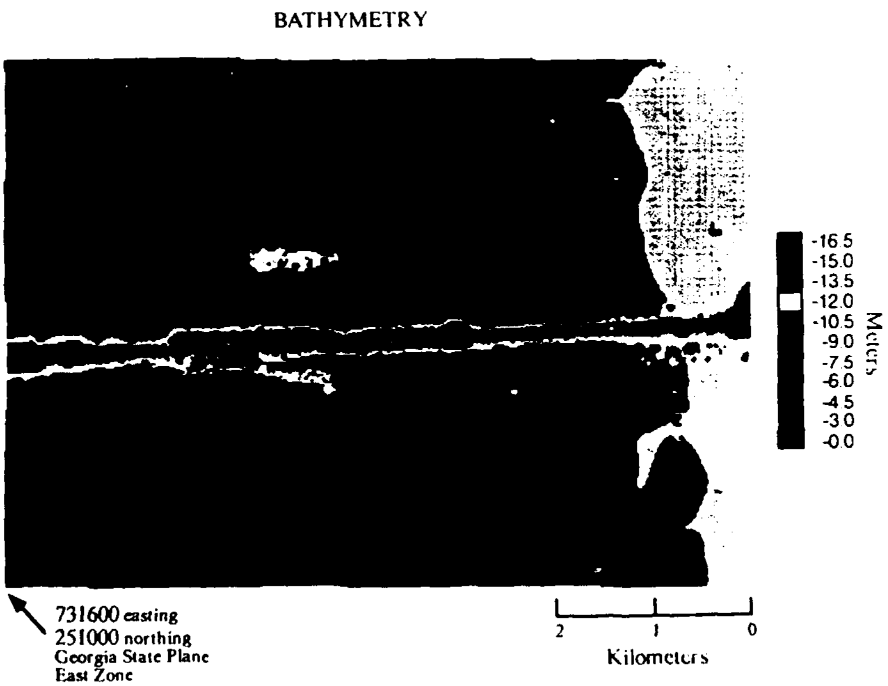

Fig. 8 — The distribution of water depths in the survey area are shown as color coded regions that are defined on the right side of the figure. The heavy black lines on the left side of the map represent the stone jetties that protect the river entrance.

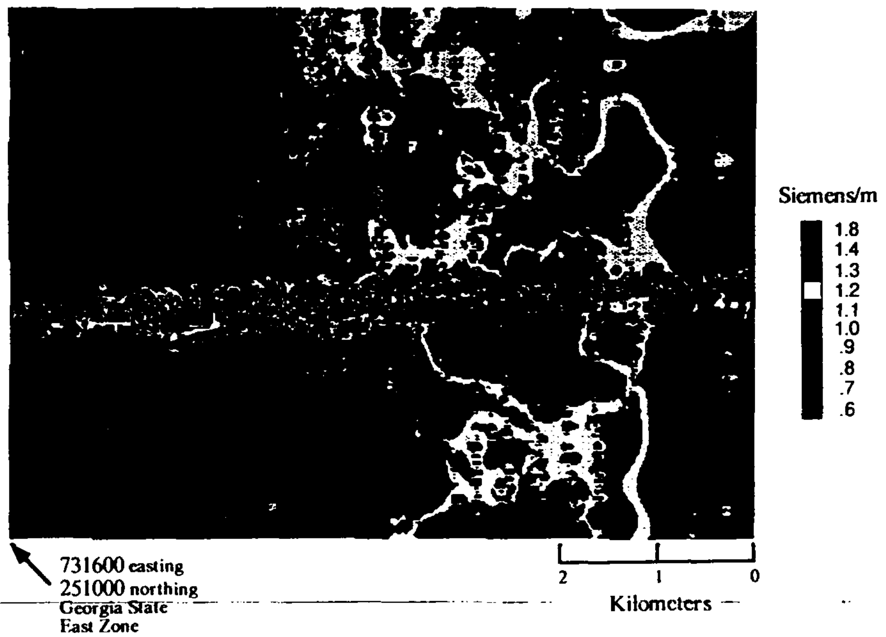

Fig. 9 — The sediment conductivity variations are displayed according to the color coded map. The values vary over 300% moving from the beach on the left side of the map to the seaward side.

proved to be an important tool to remotely measure multiple oceanographic and geotechnical parameters.

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[Sponsored by CNO]

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The High Temperature Superconductivity Space Experiment (HTSSE)

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The High Temperature Superconductivity Space Experiment (HTSSE) program was initiated by NRL in 1988. The HTSSE program is being developed and managed by NRL. The overall goal is to demonstrate the potential advantages of high-temperature superconductor (HTS) electronic components subsystems in space. The first phase of the program is HTSSE-I, which will prove that passive HTS microwave devices have the ability to survive